MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

ETN2126 – INFORMATION THEORY AND ERROR CODING

(TE, MCE)

29 FEBRUARY 2016
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with **FOUR** (4) Questions only.

2. Attempt ALL **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) A channel matrix is described by **Figure 1** as follows:

$$\begin{array}{cc} & \text{Outputs} \\ & \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \text{Inputs} \begin{array}{c} x_1 \\ x_2 \\ x_3 \end{array} & \begin{bmatrix} 1/3 & 2/3 & 0 \\ 3/10 & 0 & 7/10 \\ 0 & 2/5 & 3/5 \end{bmatrix} \end{array}$$

Figure 1

The input *a priori* probabilities are given as $\{x_1, x_2, x_3\} = \{0.6, 0.3, 0.1\}$.

(i) Sketch the Discrete Memoryless Channel (DMC) diagram given the inputs in **Figure 1.**

[1 mark]

(ii) Calculate the entropy $H(A_X)$ and $H(A_Y)$.

[6 marks]

(iii) Compute $P(x_1|y_1)$, $P(x_1|y_2)$, $P(x_2|y_3)$ and $P(x_3|y_1)$.

[4 marks]

(b) A telephone circuit has a capacity of 6500 bits/s and a bandwidth of 4 kHz. Determine the SNR of the circuit for error free transmission in dB.

[4 marks]

Continued.....

Question 2

(a) Discuss how channel encoding and channel decoding is used to reduce *transmission error.*

[2 marks]

(b) A Huffman code tree is shown in **Figure 2** below.

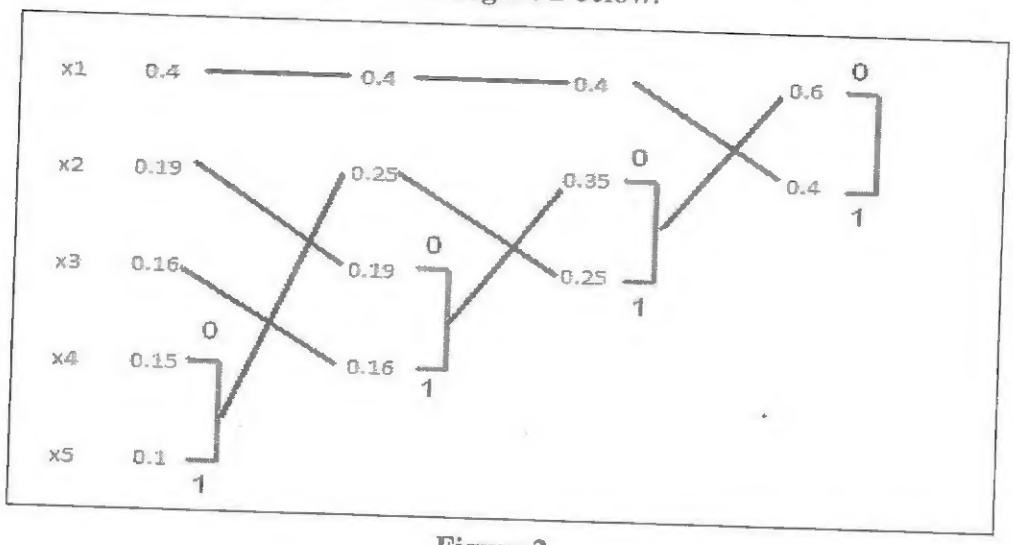

Figure 2

(i) Find the codewords for the Huffman code.

[1 mark]

(ii) Determine the efficiency of the code.

[4 marks]

(c) The generator polynomial of a (15, 11) cyclic code is $g(D) = 1 + D^2 + D^4$.

(i) Design and draw the circuit diagram for the encoder above. Label all components used in your design carefully.

[3 marks]

(ii) Using the polynomial division method, find the codeword for the message 00000000101.
(Hint: Use systematic form)

[5 marks]

Continued.....

Question 3

(a) A rate 1/3 convolutional encoder with a constraint length, K=3, is envisioned for use in a transmission system.

(i) Design the encoder with the following generator polynomials:

$$g^1 = [1,0,1]$$
$$g^2 = [1,1,1]$$
$$g^3 = [1,1,0]$$

[5 marks]

(ii) For the encoder in part (a), find the codeword that corresponds to the message $m(D) = 1+D+D^2+D^4$

[6 marks]

(b) Trellis coded modulators consist of a Trellis encoder and a signal constellation mapper as shown in **Figure 3**. A Trellis convolutional encoder is inputted with an n=3 bits/symbol signal.

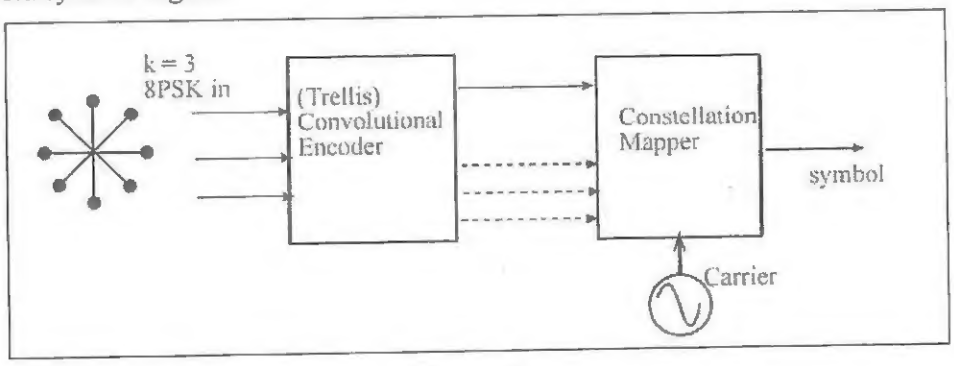

Figure 3

(i) Calculate how many signal points are required for increased spectral efficiency in the design of the TCM coded system in part (b).

[2 marks]

(ii) If the system requires a linear transmission path, draw **ONE** signal constellation for the implementation of the coded system. Give **ONE** justification for your choice of constellation.

[1+1 mark]

Continued.....

Question 4

(a) **Figure 4** shows the state diagram of an encoder. If the encoder is initialized to **01**, find the output of the encoder for an input string of 1101101 using a Trellis diagram.

[4 marks]

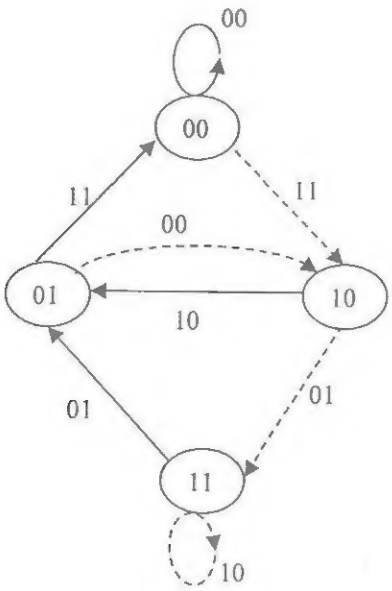

Figure 4

(b) A Hamming (7, 4) code with the parity check code **H** given below is used to produce a codeword.

$$\mathbf{H} = \begin{bmatrix} 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$

(i) Determine the codeword for the message bits 0101.

[4 Marks]

(ii) If a codeword 1011010 is received, locate and correct the bit in error.

[4 Marks]

Continued.....

Question 4 (continued)

(c) Soft decision decoding and hard decision decoding are two methods used by the receivers in transmission systems to detect transmitted symbols.

(i) State the type of decision decoding used in Trellis Coded Modulation (TCM)

[1 mark]

(ii) Discuss **ONE** advantage of using this type of decoding in information transmission.

[2 marks]

End of Paper